Generative Adversarial Networks

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Abstract

Generative Adversarial Networks (GANs) are a type of deep learning techniques that have shown remarkable success in generating realistic images, videos, and other types of data. This paper provides a comprehensive guide to GANs, covering their architecture, loss functions, training methods, applications, evaluation metrics, challenges, and future directions. We begin with an introduction to GANs and their historical development, followed by a review of the background and related work. We then provide a detailed overview of the GAN architecture, including the generator and discriminator networks, and discuss the key design choices and variations. Next, we review the loss functions utilized in GANs, including the original minimax objective, as well as more recent approaches s.a. Wasserstein distance and gradient penalty. We then delve into the training of GANs, discussing common techniques s.a. alternating optimization, minibatch discrimination, and spectral normalization. We also provide a survey of the various applications of GANs across domains. In addition, we review the evaluation metrics utilized to assess the diversity and quality of GAN-produced data. Furthermore, we discuss the challenges and open issues in GANs, including mode collapse, training instability, and ethical considerations. Finally, we provide a glimpse into the future directions of GAN research, including improving scalability, developing new architectures, incorporating domain knowledge, and exploring new applications. Overall, this paper serves as a comprehensive guide to GANs, providing both theoretical and practical insights for researchers and practitioners in the field.